REMARKS

This amendment is submitted in response to the Final Rejection dated August 3, 2010. Claims 2-3 and 21 have been canceled without prejudice to resubmission. After entry of this amendment, claims 1, 4-20 and 22-32 will remain pending in the application. Claims 1, 4, 20 and 32 have been amended. No new matter has been added.

1. Allowable Subject Matter

Claims 4, 9-10, 12 and 22 have been objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The Applicant appreciates the indication of allowable subject matter; however the Applicant believes that the claims from which claims 4, 9-10, 12 and 22 depend are now in condition for allowance and requests notice to that effect.

2. The Claim Amendments

Claim 1 has been amended to require that the first signal having an omni-directional polar pattern is derived from one of two omni-directional microphones. Basis for this amendment is found, for example, at page 9, line 30 of the original specification.

Claim 1 has also been amended to require that the second signal having a bi-directional polar pattern is derived from the two omni-directional microphones. Basis for this amendment is found, for example, at page 9, lines 15-18 of the original specification.

Claim 1 has also been amended to require that the first and second signal weights are calculated in a non-iterative manner, by taking this limitation from prior claim 2.

Claim 1 has also been amended to require that the first and second signal weights are calculated by an optimiser, shown as element 38 in Figure 3 and described at page 9, line 31 et seq. of the specification.

Claim 1 has also been amended to require that the optimiser take the first and second signals as inputs, basis for which can be found, for example, in Figure 3 and at page 9, lines 30-31 of the specification.

Claim 1 has also been amended to require that the optimiser determine the first and second signal weights from the first and second signals by mathematically calculating the first and second signal weights in a manner to comply with predefined constraints, basis for which is found, for example, on page 8, lines 17-19 of the specification.

Claim 1 has been further amended to require that the weighted sum gives the combined adaptive directional signal a constant gain in a predetermined direction by imposing a constraint that the first and second signal weights add to a predetermined value. This amendment is taken from prior claim 3 of the application.

Finally, claim 1 has been amended to specify that the power of the combined signal is substantially minimized by ensuring that the derivative with respect to signal weight of the energy of the output signal is about zero. Basis for this amendment is found, for example, on page 11, line 20 of the application as originally filed.

Similar basis applies for the amendments made to claims 20 and 32. In addition, claim 20 has been further amended to require a differencing element, basis for which is found, for example, on page 9, line 17 of the original specification.

Claim 4 has been amended to make it dependent on amended claim 1.

3. The Outstanding Rejections

Claims 1-3, 5-8, 17-21, 23-25 and 32 have been rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent no. 7,076,072 (Feng). This rejection, at least insofar as it applies to the amended claims, is traversed and reconsideration and withdrawal of the rejection is requested.

The claim amendments insert several additional limitations which applicant believes are not taught or suggested by Feng. For example, Feng does not appear to teach or suggest deriving a first signal having an omni-directional polar pattern from one of two omni-directional microphones. Feng also does not appear to teach deriving a signal having a bi-directional polar pattern from the same two omni-directional microphones from which the first signal is derived.

The claims have also been amended to require that the first and second signal weights are calculated by an optimizer which takes the first and second signals from the omni-directional microphones as inputs. This feature of the amended claims is not taught or suggested by Feng.

The claims have been further amended to require that the optimiser determine the first and second signal weights from the first and second signals by mathematically calculating the first and second signal weights in a manner to comply with predefined constraints. This limitation of the claims also appears to be lacking from Feng. The Examiner refers to the mention of constant gain at col. 6, lines 51-60 of Feng in relation to this feature. However, Feng does not appear to teach that the combined signal weights should add to a predetermined value, as is now claimed.

The Examiner asserts that "Feng discloses deriving different responses from microphones combinations (col. 4 lines 1-40)". However, it is not the case that Feng col. 4 lines 1-40 discloses combining sensor signals to derive the polar patterns shown in Figures 2-5. Rather, each directional pattern in Figures 2-5 is an example of a fixed directional pattern output by particular hardware, prior to any signal processing such as combining.

One example given by Feng (col. 4 line 20) is a bi-directional "pressure-difference type microphone". Such a device consists of two input ports passing acoustic signals to opposing sides of an electro-acoustic transducing membrane or diaphragm. Because acoustic signals arrive from opposing sides, the membrane itself effects a "mechanical subtraction" of the two acoustic signals. To carry acoustic signals from outside a device casing to the ports of any microphone, input tubes or like conduits are invariably provided. These tubes can slide on friction mountings and thereby alter the signal path length, can be deformed by being pinched or compressed within or by the casing, or can be occluded by introduced material. These and other physical path changes affect acoustic input paths of both omni- and bi-directional sensors. However bi-directional sensors cannot be re-matched to compensate for path changes because signal subtraction occurs in the hardware and thus cannot be tuned. Feng's reliance upon directional sensors precludes the possibility of any matching either for device mismatches or degradation.

By contrast the present invention, by exploiting two omni-directional sensors, carries out signal subtraction not in hardware but in software or signal processing. This allows the omni-directional microphone output signals to be phase-adjusted or modified in amplitude (e.g. see gain 35 in Fig 3, page 8 lines 5-11 and page 9 lines 27-29 of the present application) prior to any subtraction. This permits phase and amplitude matching to be optimized at the time of

manufacture to compensate for manufactured device mismatches, and also permits re-optimization over time, as and when physical components degrade or alter. Thus the present invention inherently gives significantly more flexibility in the manner in which the first omni-directional signal and second bi-directional signal may be matched in amplitude and phase.

The processing of the present invention works upon two specifically selected signals: a first signal which is omni-directional, and a second signal which is bi-directional, with both signals being derived from the same two omni-directional microphones. This is a critical selection which is not disclosed or suggested by Feng. This arrangement provides a highly effective, elegant and simple means to ensure that the bi-directional signal is precisely in phase with the omni-directional signal in the predetermined (e.g. forward) direction, while ensuring that the bi-directional signal is precisely 180 degrees out of phase with the omni-directional signal in the opposite (e.g. rear) direction. Such precise phase configurations are an essential factor in effective operation of a processing system in which it is required that: (1) addition of the two signals when equally weighted will effect precise cancellation (i.e. a deep null) in the rear direction; (2) subtraction of the two signals when equally weighted will effect precise cancellation in the forward direction; and (3) precise cancellations will occur at other polar angles under suitable weightings. In contrast, basic theory indicates that the use in Feng of different hardware and different types of hardware as the origin of each signal path, with no opportunity for matching (as previously explained), makes it almost certain that the signals will not be closely phase aligned in the above manner. It is thus inherent in the teaching of Feng that precise phase alignment will be exceedingly difficult to obtain, inevitably resulting in poor nulls. Feng in no way gives any teaching, suggestion or motivation to implement the specifically selected (and claimed) elements of the present invention for the purpose of addressing this significant problem.

It is further noted that hearing aids in particular, and to a similar extent Bluetooth headsets and the like, have very limited physical space to accommodate microphone ports. For example in hearing aids the maximum port spacing can typically be no more than about 1 centimeter. In this space must be mounted not only microphone ports at relative positions to maximize performance, but also other elements such as wind shields to reduce wind noise. Utilization of this space is a difficult task. The present invention, in utilizing two omni-

directional microphones, requires only two microphone ports. Feng requires that both sensors 22 and 24 are directional, thus necessitating at least four microphone ports in any such device, significantly hampering the achievable performance of each hardware sensor.

Feng (col. 3 lines 62-67) states that directional sensor 22 may have any of the fixed hardware responses shown in Figures 2-5 and discussed at col. 4 lines 1-40, as may directional sensor 24. That Feng (col. 4 lines 1-40) discusses the respective basic polar characteristic of each such example of a fixed hardware directional sensor is not contested by the applicant. However, Claim 1 of the present application requires "deriving from two omni-directional microphones a first signal having an omni-directional polar pattern" and "deriving from the two omni-directional microphones a second signal having a bi-directional polar pattern". Feng col. 4 lines 1-40, and indeed the entirety of Feng, nowhere discloses nor suggests deriving first and second signals from the same two omni-directional microphones, the first signal being omni-directional and the second signal being bi-directional.

Feng describes a system which relies on two or more directional sensors that are combined to give an adaptive directional signal. Notably, it is the sensors of Feng which are directional. This is in contrast to claim 1 of the present application which, as previously amended, requires that the two signals be derived from omni-directional microphones. Applicant does not contend that omni-directional and bi-directional sensors *per se* are not known. However the architecture of Feng necessarily uses directional sensors and, when seeking to effect adaptive directionality therefrom, this inextricably requires a different type of signal processing optimization. Consequently, the Feng architecture is fundamentally different and cannot achieve the same type of behavior and performance as the present invention. In contrast, the architecture of the present invention necessarily uses two omni-directional sensors (as is set out in claim 1), to enable this invention's very particular architecture (also set out in claim 1) to function and achieve its performance. The signal processing techniques of Feng cannot be used in the architecture of the present invention, and simply would not work. Accordingly, even if it were obvious (which is not conceded) to try to use omni-directional sensors in the architecture of Feng, this would not yield the present invention, nor even a useful arrangement.

The Examiner also takes the position that "the adaptive signal processing is applicable to microphones of various response patterns (col. 18 lines 30-37)". However, Feng at col. 18 lines

30-37, and indeed the entirety of Feng, nowhere discloses nor suggests deriving first and second signals from the same two omni-directional microphones irrespective of the presence or absence of any bi-directional microphones. In more detail, we note Feng (col. 18 lines 32-35) states "In other alternative embodiments, at least one acoustic sensor is of a directional type while at least one other of the acoustic sensors is of an omni-directional type". This statement thus mentions the possibility of including omni-directional microphones in addition to directional microphones. Applicant notes Feng gives no further disclosure of how such a system may be implemented or how the additional omni-directional microphones may advantageously be exploited. Much less does this statement give any teaching or suggestion to derive first and second signals from the same two omni-directional microphones, irrespective of the presence or absence of any bi-directional microphones, as required by claim 1 of the present application.

Further, Feng (col. 18 lines 35-37) states "In still other embodiments based on more than two sensors, two or more sensors may be omnidirectional and/or two or more may be of a directional type". This statement applies to a system with "more than two sensors", and thus gives no teaching or suggestion to derive first and second signals from the same two omni-directional microphones, irrespective of the presence or absence of any bi-directional microphones, as required by claim 1 of the present application. Applicant notes that the "and/or" language of Feng (col. 18 line 37) at most entertains the possibility of a system comprising three or more omni-directional sensors. Accordingly, this gives no teaching or suggestion to derive first and second signals from the same two omni-directional microphones. Moreover, Feng nowhere teaches any sort of signal processing which might be used to handle signals from three or more omni-directional sensors. Applicant again notes that all processing methodologies taught throughout the remainder of Feng inextricably arise from the use of directional sensors and are ineffective with omni-directional microphone signals.

At page 2 final two lines and page 3 first line, the final Office Action asserts that Feng (Fig. 3 and col. 4, lines 19-30) discloses "deriving from two omni-directional microphones a first signal having an omni-directional polar pattern and a second signal having a bi-directional polar pattern". However, Applicant again notes that Fig. 3 is a graph of the response pattern of a single microphone (see col. 4 line 20). The microphone itself is bi-directional (col. 4 lines 20-21), not omni-directional. Fig.3 and col. 4, lines 19-30 thus fail to disclose any omni-directional

microphones whatsoever, much less providing any disclosure or suggestion of deriving first and second signals from the same two omni-directional microphones. Feng (col. 4, lines 16-18) refers to the circular polar pattern of an omni-directional microphone by reference to "outer circle OC" in Fig. 2, but this is "in contrast" (col. 4, line 16) and clearly present merely for comparative purposes in order to define what is not considered to be a directional microphone, with Feng (at col. 3 line 62) making clear that the sensors 22 and 24 discussed throughout col. 4 are in all cases directional.

The second final Office Action at page 3, first four lines, asserts that Feng (Fig 6-7, col. 6, lines 13-30, col. 18, lines 30-37) discloses "constructing the combined adaptive directional signal from a weighted sum of a first signal weight of the first signal and a second signal weight of [the] second signal". However, it is again noted that Feng nowhere discloses constructing a combined adaptive directional signal from a weighted sum of first and second signals, where both signals have been obtained from the same two omni-directional microphones, and where the first signal is omni-directional and the second signal is bi-directional.

The final Office Action at page 3, line 7 concedes that Feng does not disclose the specific selection of the second signal having a bi-directional polar pattern. At page 3, lines 10 to 12 the Examiner contends that "it would have been obvious to one of ordinary skill in the art at the time of the invention to try various directional microphones". Applicant notes that the present invention does not use directional microphones, but rather uses omni-directional microphones. Applicant further notes that, for the reasons set out in the preceding discussion, even if it were obvious (which is not conceded) to try to use omni-directional sensors in the architecture of Feng, simply substituting omni-directional microphones into the architecture of Feng would be ineffectual and would not yield the present invention, nor even a useful arrangement.

The final Office Action at page 3, lines 12-14 states that "obtaining various directional responses from an omni-directional microphone is very well known in the art at the time of the invention as evidenced by Feng (col. 4, lines 1-40)". As noted previously, Feng col. 4, lines 1-40 makes no disclosure whatsoever of obtaining directional responses from omni-directional microphones.

The Final Office Action at page 3 lines 10, 15 and 17 asserts that it would have been obvious to one of ordinary skill in the art to reach the present invention. However, as an

indication of the non-obviousness of the present invention, it is noted that this invention has been assessed and licensed by major companies including leading hearing aid manufacturers such as ON Semiconductor Corp. (formerly Sound Design Technologies Ltd), IntriCon Corp, America Hears Inc., a G.N. Store Nord A/S subsidiary GN ReSound Ltd (under the brand Interton), and other hearing aid manufacturers, and has also been licensed in confidence to several Tier 1 Bluetooth Headset manufacturers who have sold millions of units which utilize this invention. These licensees are leaders in these fields and employ persons having much greater than "ordinary" skill in the field who have carefully assessed this invention and recognized the significance of the present invention and consequently elected to take a license to this invention. It is respectfully submitted that this further confirms that persons of merely ordinary skill in this field most certainly would not have found the present invention to be obvious.

As a further indication of the non-obviousness of the present invention, it is noted that the corresponding Australian Patent (AU 2004310722) has been granted by the Australian Patent Office.

It is respectfully submitted that the preceding arguments illustrate that claim 1 is novel and non-obvious. The same arguments apply to all of the remaining claims in the application either because they depend from claim 1 or because they include the same limitations as claim 1 which are relied upon above in support of the patentability of the invention. The secondary references cited by the Examiner do not cure the deficiencies of Feng discussed herein nor does the Examiner allege that the features lacking from Feng are found in the secondary references.

4. Conclusion

Applicant has made an earnest effort to place this application in condition for allowance. If the Examiner feels that a telephone interview would expedite prosecution of this patent application, he or she is respectfully invited to telephone the undersigned at 215-599-0600.

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